Human Movement Science 61 (2018) 99–108

Contents lists available at ScienceDirect

Human Movement Science

journal homepage: www.elsevier.com/locate/humov

Full Length Article

Kick impact characteristics of accurate Australian football drop punt kicking

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ARTICLE INFO

Keywords:
Biomechanics of football
Football kicking accuracy
End-point variability
Functional variability
Dysfunctional variability

ABSTRACT

Accurate kicking is essential to team success in Australian football. It is not known how foot-ball impact characteristics influence kicking accuracy, nor is it known if variability in foot-ball impact characteristics is functional or dysfunctional to performance. The aim of this study was to identify the relationship between foot-ball impact characteristics and kicking accuracy and determine if variability in foot-ball impact characteristics influenced performance variability. Ten players performed 30 drop punt kicks toward a target with an Australian football ball. Kicking accuracy (measured as the horizontal distance from the target in the perpendicular direction of the kick), initial ball flight characteristics, and foot-ball impact characteristics, including a novel method to calculate impact location on the ball, were measured. Variability was indicated using standard deviation of foot-ball impact and ball flight characteristics. Multiple linear regression analysis identified azimuth ball flight trajectory as the most important ball flight characteristic influencing kicking accuracy, not ball flight characteristics associated with ball curve. Intra-individual multiple linear regressions identified azimuth ball impact location and foot-ball angle were the two most important factors explaining variance in azimuth ball flight trajectory, the chosen performance measure. Variability existed between and within players. Reduced variability in azimuth ball flight trajectory, the chosen performance measure, was associated with reduced variability in foot-ball impact characteristics. This result indicated variability in foot-ball impact characteristics was dysfunctional for performance in the analysed task. Foot-ball impact characteristics and variability in foot-ball impact characteristics influences accuracy of Australian football drop punt kicking.

1. Introduction

Kicking is an important skill across the football codes. Under certain gameplay situations, the demand of accuracy for kicking is high. In Australian football, kicking with high accuracy is required to successfully score goals, to pass to team members, and to clear the ball when relieving defensive pressure. The drop punt kick is the most common kicking style in Australian football. The drop punt kick is characterised by the player releasing the ball from his/her hands, forcefully impacting the ellipsoidal ball with the long axes of the foot and ball aligned, and imparting a distinct back-spin for ball flight. Because the ball is in projectile motion after it leaves the foot, accurate kicking is achieved by imparting an appropriate combination of flight characteristics required to reach the target.

Research exploring the foot-to-ball impact phase (hereafter referred to foot-ball impact) of Australian football drop punt kicking has focused almost entirely upon the production of ball speed. It is clear that foot speed immediately prior to impact is the most

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https://doi.org/10.1016/j.humov.2018.07.009
Received 20 February 2018; Received in revised form 16 July 2018; Accepted 22 July 2018
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important contributor toward ball speed (Ball, 2008, 2011; Ball, Smith, & MacMahon, 2010; Peacock & Ball, 2017) and is a strategy used by players to alter kick distances (Peacock, Ball, & Taylor, 2017). Despite the large contribution of foot speed to ball speed, players must still control other ball flight characteristics to ensure adequate energy transfer from foot to ball. Recent analyses with a mechanical kicking machine have identified ball orientation and impact location at the beginning of impact and ankle stiffness throughout impact influence ball speed (Peacock & Ball, 2017, 2018a,b).

How players configure their foot-ball impact characteristics to attain accurate kicking is almost entirely unexplored. Research has identified how individual impact characteristics influence individual ball flight characteristics across different football kicking codes. However, given the importance of kicking accuracy required for goal scoring, passing and overall team success, further work is required to provide the link between these impact characteristics with a measurement of kicking accuracy. In the Australian football drop punt kick, impact location, ball orientation and foot speed were influential to ball flight characteristics of back-spin rate and azimuth ball flight trajectory in an analysis with a mechanical kicking machine (Peacock & Ball, 2017). In the soccer instep kick, a trade-off between impact location and ball speed and ball spin has been identified (Asai, Carré, Akatsuka, & Haake, 2002; Ishii, Yanagiya, Naito, Katamoto, & Maruyama, 2009). These studies indicate the importance of foot-ball impact characteristics toward individual ball flight characteristics, and work is required to provide the link between impact and kicking accuracy.

While identification of the direct mechanisms associated with accurate football kicking is important, understanding how a player varies their technique over several repetitions can also help explain kicking accuracy. The ultimate measure of performance for accurate kicking is the final position of the ball relative to the desired target. In gameplay of Australian football, an attempt at goal is only successful when the final position of the ball travels within the goal posts. Performance variability is the distribution of the final position over several repetitions, and can be easily identified in gameplay by attempts at goal that were either successful or unsuccessful. Arguably of more importance to human movement scientists is the variability in the movement pattern that produces the outcome of the task (Bartlett, Wheat, & Robins, 2007). Somewhat surprisingly, it has been identified that better skilled players, those that produce less performance variability (i.e. more consistent, successful accurate outcomes), produce more movement variability in the proximal segments than the less skilled counterparts (Arutyunyan, Gurfinkel, & Mirskii, 1968; Robins, Davids, Bartlett, & Wheat, 2008). Thus, to achieve accurate end-point positions, skilled players do not consistently produce an 'ideal' or 'optimal' technique (Glazier, Reid, & Ball, 2015). In the context of football kicking, some researchers have sought to identify if better skilled football players utilise increased or decreased variability in the approach and swing phases of various football kicking techniques (Ford & Sayers, 2015; Morris, Sayers, & Stuelcken, 2016; Sayers & Morris, 2012). It has been argued that increased variability can be functionally used by players to adapt to different gameplay conditions incurred from fatigue, surface conditions and playing environment (Ford & Sayers, 2015). Thus, increased variability can be either functional or dysfunctional, depending on the event or phase of analysis throughout the kicking execution (i.e. proximal segments, end-point position or performance outcome).

It is not known if accurate drop punt kicking is achieved through increased or decreased variability at foot-ball impact, nor has this been assessed in any football kicking technique. The analysis of impact characteristics during the golf drive identified better skilled players reduced variability in impact characteristics (Betzler, Monk, Wallace, & Otto, 2014). This finding is relevant for football kicking, as golf and football kicking both accelerate the ball via a collision. However, the ball shape distinctly differs between the tasks, with an ellipsoidal shape used in Australian football and spherical ball in golf. This unique ball shape of Australian football may lead to degeneracy at foot-ball impact of the drop punt kick. Peacock and Ball (2017) identified individual impact characteristics (impact location, ball orientation, etc.) influenced several ball flight characteristics. Players could therefore use multiple combinations of impact characteristics to achieve similar ball flight characteristics and accurate kick outcomes. Skilled players might utilise this redundancy to remove any errors in technique introduced during the leg swing of the kicking skill by functionally varying foot-ball impact characteristics. Thus, when performing the Australian football drop punt kick, there are two distinctly different strategies that a player might be able to use to produce accurate football kicking, (1) reducing the magnitude of variability in foot-ball impact characteristics or (2) functionally increasing variability in foot-ball impact to mitigate errors incurred during the forward swing and ball drop.

The aim of the present study was to identify how foot-ball impact characteristics influence kicking accuracy in the Australian football drop punt kick. Accurate drop punt kicking in Australian football is important to overall team success, as it is the main technical skill used for scoring and passing moderate and long distances. The link between foot-ball impact characteristics with kicking accuracy has not been established, nor is it understood how accuracy is influenced by movement variability at foot-ball impact. Thus, to further understand how accurate kicking is obtained, the first aim of the study was to identify the relationship between foot-ball impact and kicking accuracy by (1A) identifying the relationship between ball flight characteristics and kick accuracy and (1B) identifying the relationship between foot-ball impact and ball flight characteristics. This process of working backwards from the outcome systematically allowed the direct mechanisms to be identified. The second aim of the study was to identify if performance variability was associated with increased or decreased levels of variability in foot-ball impact characteristics.

2. Methods

2.1. Task

After signing informed consent forms approved by the university's human research ethics committee, ten players of various experience (2–15 years playing competitively) kicked a standard Australian football (Sherrin Match Ball; inflation = 69 kPa) from a defined kicking area toward a player 30 m in distance. Each player performed this kick 30 times. The player catching the ball was instructed to move across the 30-m line perpendicular to the kick direction and catch the ball. This task simulated a common pass

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